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Agarwal et al.

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(54) **METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR PROVIDING A MULTI-NETWORK EQUIPMENT IDENTITY REGISTER**

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(51) **Int. Cl.**
H04W 12/06 (2009.01)
H04L 29/06 (2006.01)

(52) **U.S. Cl.**
CPC *H04W 12/06* (2013.01); *H04L 63/0876* (2013.01); *H04L 63/101* (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/663; H04W 12/06; H04L 67/306; H04L 63/102; H04L 63/0876; H04L 63/101
See application file for complete search history.

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(57) **ABSTRACT**

Methods, systems, and computer readable media for providing a multi-network equipment identity register are disclosed. According to one aspect, the subject matter described herein includes a system for providing a multi-network equipment identity register. A node in a telecommunications network receives from a requesting entity a request to check an identity of a user equipment, the request containing the identity of the user equipment, queries an EIR using the identity of the user equipment, receives a response from the EIR, and forwards the response to the requesting entity. The node includes first and second interfaces for receiving requests to check an identity of a user equipment in a first and second protocol, respectively, such that a user equipment that is blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol.

20 Claims, 7 Drawing Sheets

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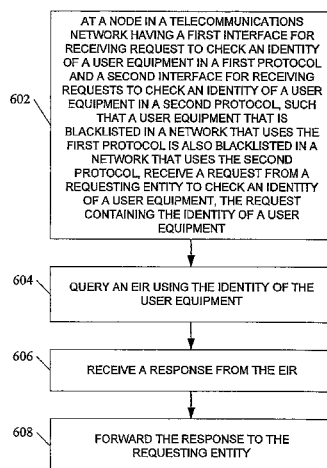
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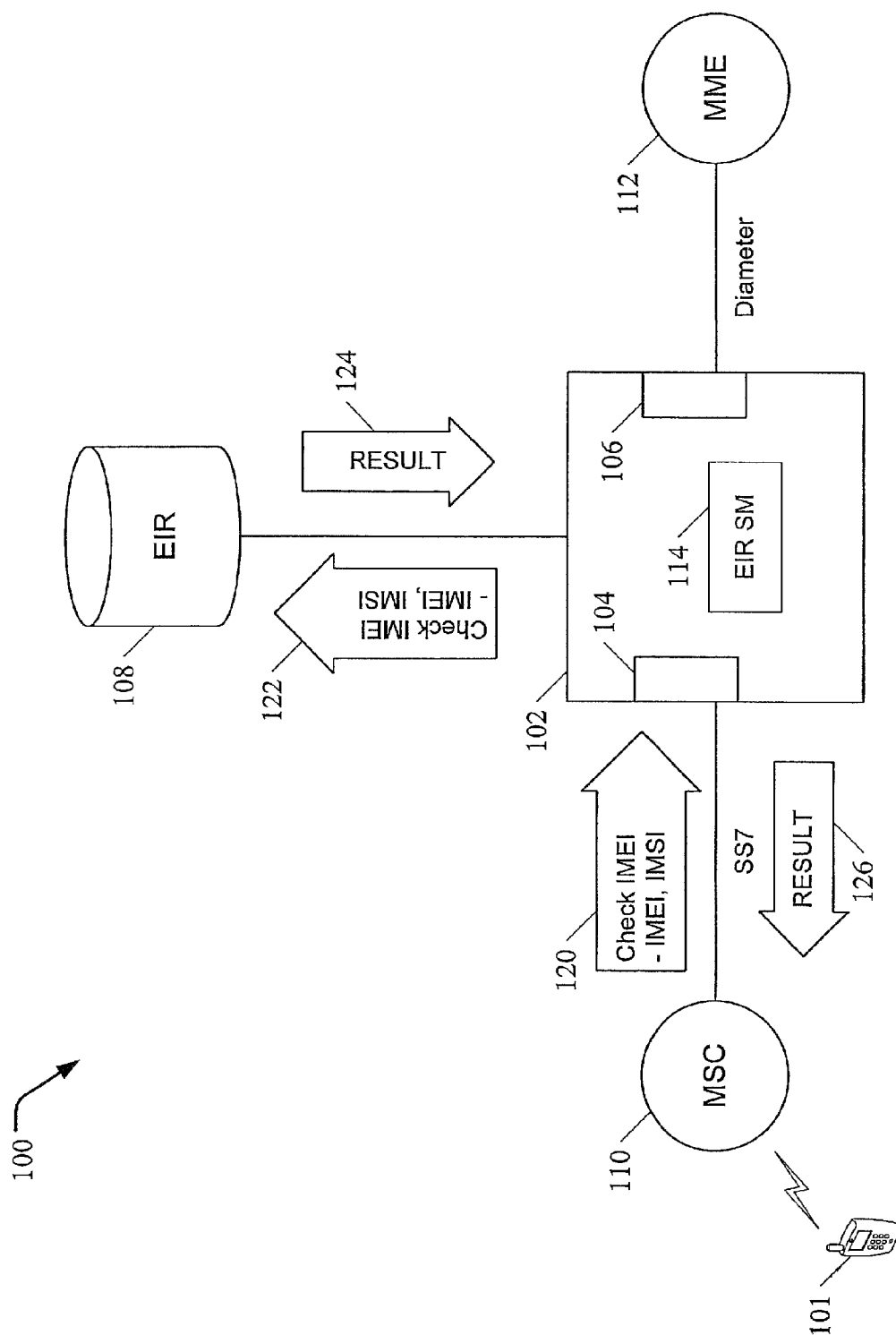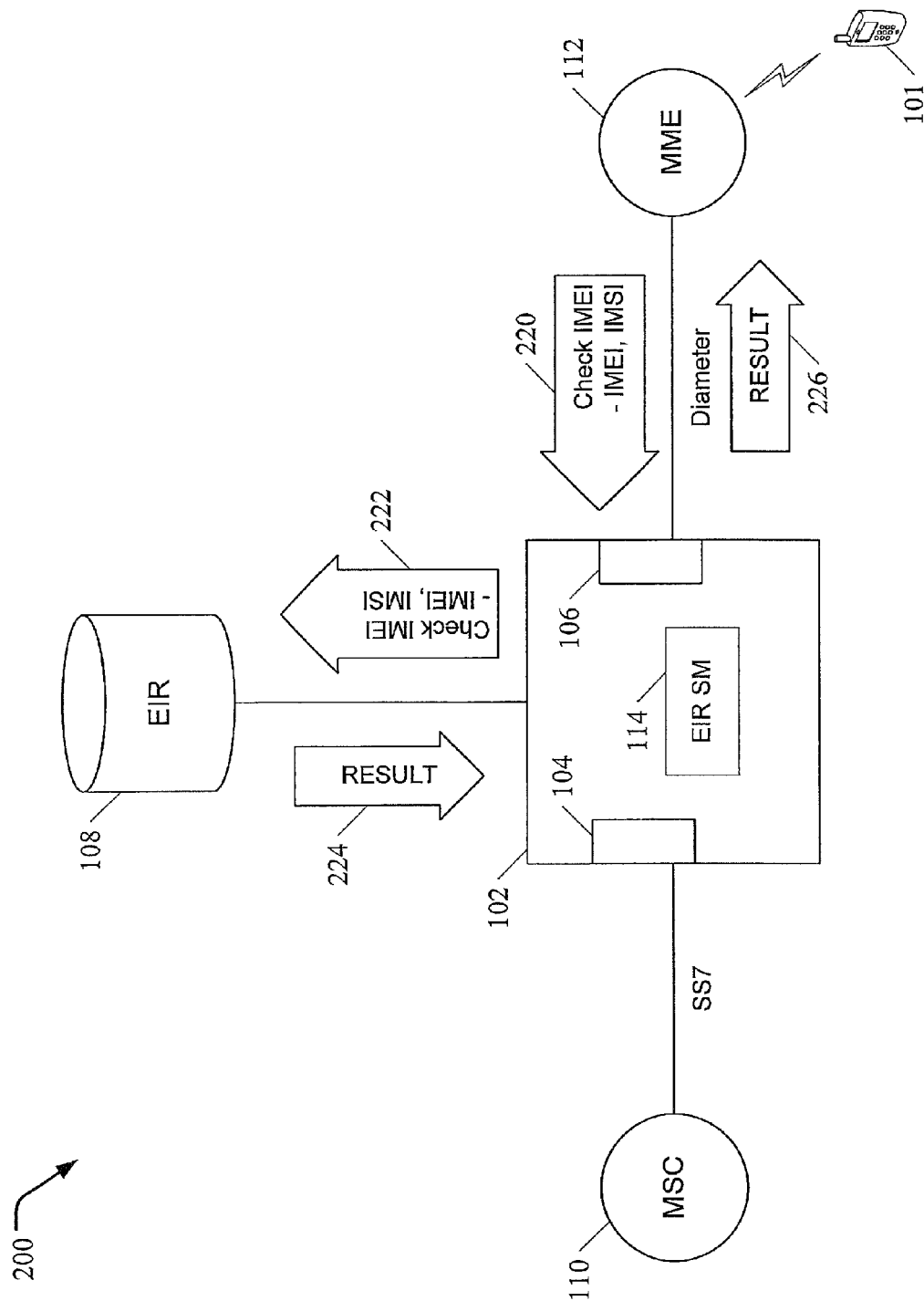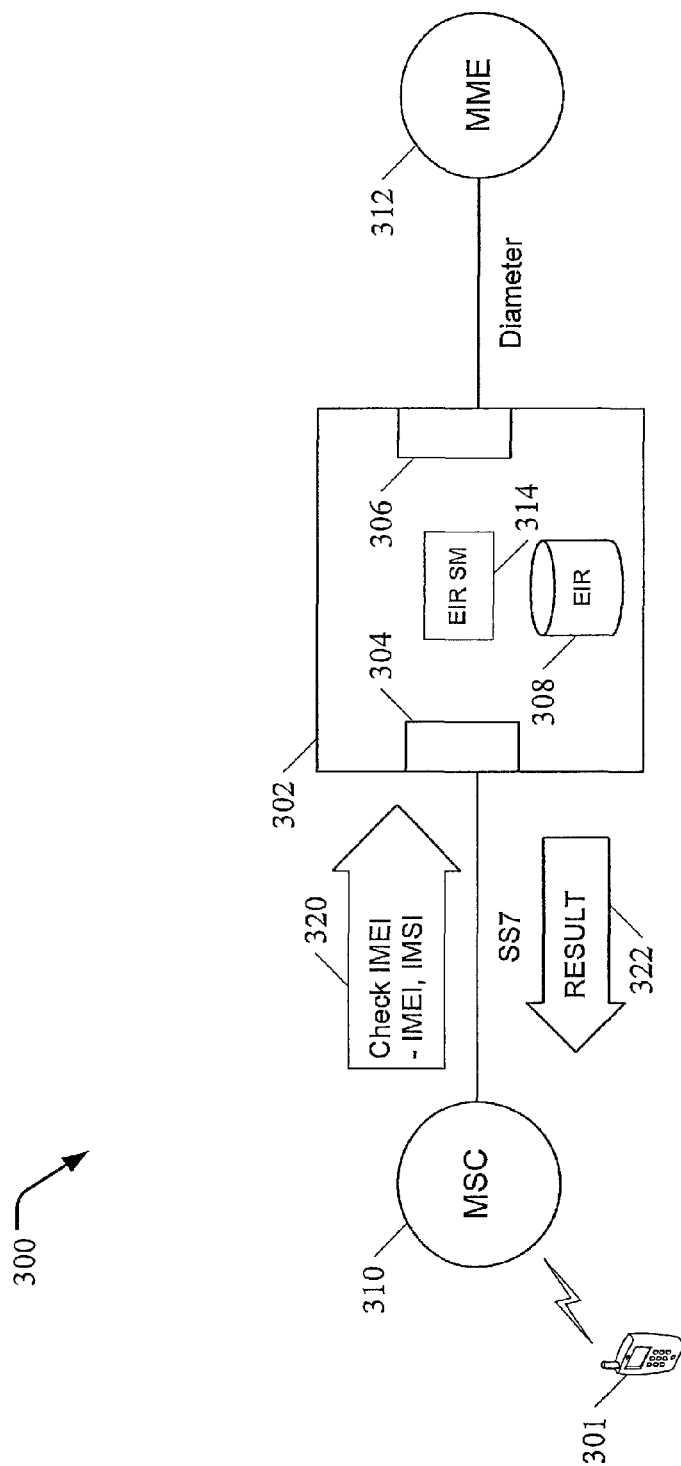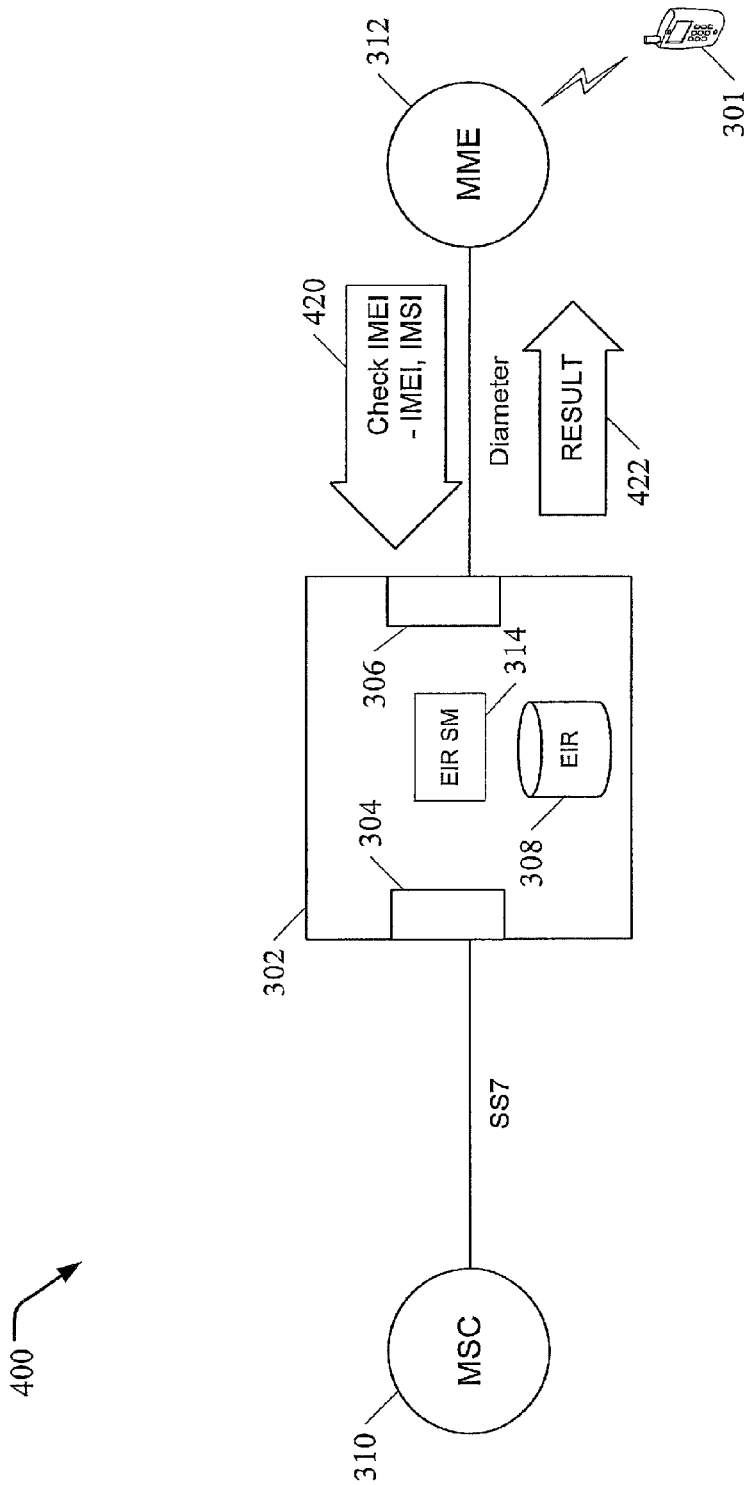
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FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

600

602

AT A NODE IN A TELECOMMUNICATIONS NETWORK HAVING A FIRST INTERFACE FOR RECEIVING REQUEST TO CHECK AN IDENTITY OF A USER EQUIPMENT IN A FIRST PROTOCOL AND A SECOND INTERFACE FOR RECEIVING REQUESTS TO CHECK AN IDENTITY OF A USER EQUIPMENT IN A SECOND PROTOCOL, SUCH THAT A USER EQUIPMENT THAT IS BLACKLISTED IN A NETWORK THAT USES THE FIRST PROTOCOL IS ALSO BLACKLISTED IN A NETWORK THAT USES THE SECOND PROTOCOL, RECEIVE A REQUEST FROM A REQUESTING ENTITY TO CHECK AN IDENTITY OF A USER EQUIPMENT, THE REQUEST CONTAINING THE IDENTITY OF A USER EQUIPMENT

604

QUERY AN EIR USING THE IDENTITY OF THE USER EQUIPMENT

606

RECEIVE A RESPONSE FROM THE EIR

608

FORWARD THE RESPONSE TO THE REQUESTING ENTITY

FIG. 6

700

MEMORY
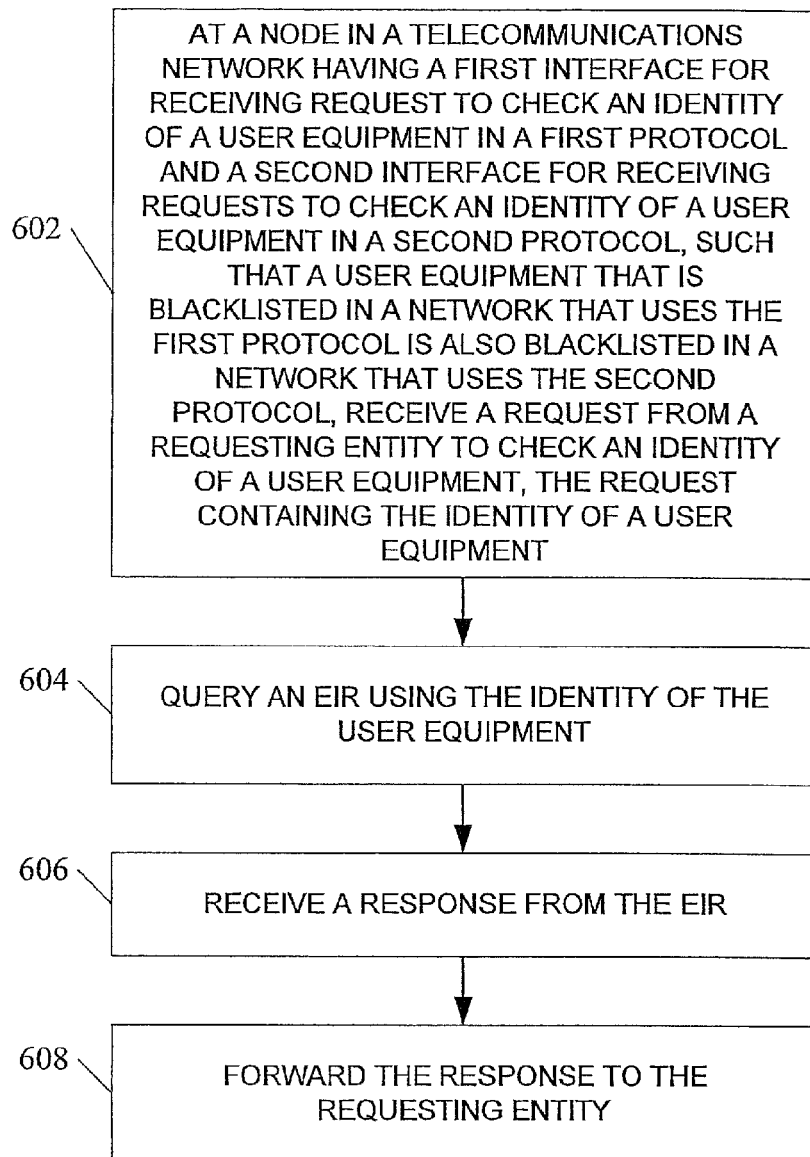704

EIR
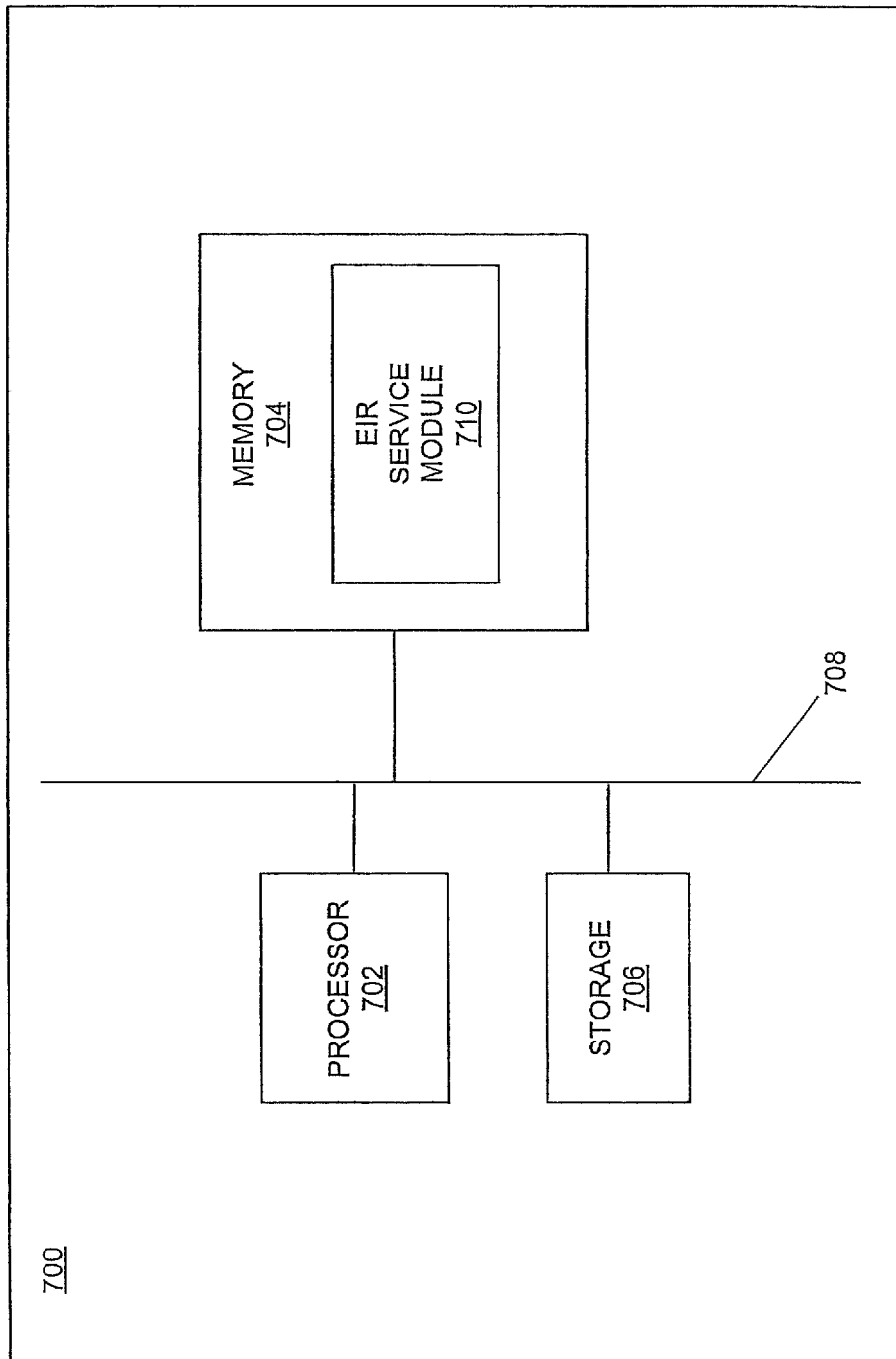SERVICE
MODULE
710

PROCESSOR
702

STORAGE
706

708

FIG. 7

METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR PROVIDING A MULTI-NETWORK EQUIPMENT IDENTITY REGISTER

PRIORITY CLAIM

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/784,694, filed Mar. 14, 2013, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The subject matter described herein relates to methods and systems for controlling access of mobile equipment to a telecommunications network. More particularly, the subject matter described herein relates to methods, systems, and computer readable media for providing a multi-network equipment identity register (EIR).

BACKGROUND

When a mobile telephone is lost or stolen, telecommunications network operators would like to deny the stolen device access to their networks. Each third generation (3G) Global System Mobile Communications (GSM) telephone includes its own unique international mobile equipment identity number (IMEI). An equipment identity register (EIR) is a database (and/or a server hosting an EIR database) that stores IMEIs of stolen or suspicious mobile devices. The EIR may be queried to determine the status of a particular IMEI. If the particular IMEI is listed in the EIR database, that may indicate that the mobile device is stolen, and the querying node may take steps to bar that device from accessing the network. When a mobile device is denied access to a telecommunications network because its IMEI is listed in the EIR, that device is said to be "blacklisted." Blacklisting is intended to discourage the theft of mobile phones by providing a mechanism that renders stolen devices from being able to connect to the telecommunications network.

Originally developed for the GSM, network, the EIR could be queried by a mobile switching center (MSC) in a system signaling 7 (SS7) network. For example, the MSC could send an SS7 mobile application part (MAP) query, such as the "Check IMEI" command, to the EIR via the GSM F interface. MAP is one of the protocols in the SS7 suite of protocols and allows for the implementation of mobile network (GSM) signaling infrastructure.

With the rise of high-speed packet networks, telecommunications networks are migrating from the circuit-switched, SS7-based networks of the plain old telephone system (POTS) to packet-switched, Diameter-based networks, which are incompatible with legacy network components such as SS7-based EIRs. Thus, network operators that want to support 4G devices face unpleasant choices: if all network equipment is migrated to 4G, then the legacy EIR database must also be migrated to a node in the packet-based network. If the network operator wants to continue supporting both 3G and 4G devices, the network operator must provide and maintain two different EIR functions—an SS7-based EIR and a Diameter-based EIR.

In addition, when a device having multiple radio interfaces is stolen, the rightful owner must notify not only the network operator that maintains the EIR for one of the radio interfaces, he or she must also notify the network operator(s) that maintain an EIR for each of the other radio interfaces—which may

not be the same network operator. As a result, in conventional systems, there is a real possibility that a stolen device may be blacklisted on a GSM network but not blacklisted on an LTE network, for example.

Accordingly, in light of these disadvantages associated with these two options, there exists a need for a mechanism that allows network operators to leverage their existing 3G EIRs so that they may be used by nodes in a 4G network. More specifically, there exists a need for a multi-network equipment identity register.

SUMMARY

According to one aspect, the subject matter described herein includes a system for providing a multi-network equipment identity register. The system includes a node in a telecommunications network that receives from a requesting entity a request to check an identity of a user equipment, the request containing an identity of a user equipment, and queries an EIR using the identity of the user equipment. The node receives a response from the EIR and forwards the response to the requesting entity. The node includes a first interface for receiving requests to check an identity of a user equipment in a first protocol and a second interface for receiving requests to check an identity of a user equipment in a second protocol, such that a user equipment that is blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol.

According to another aspect, the subject matter described herein includes a method for providing a multi-network equipment identity register. The method includes, at a node in a telecommunications network: receiving from a requesting entity a request to check an identity of a user equipment, the request containing an identity of a user equipment; querying an EIR using the identity of the user equipment; receiving a response from the EIR; and forwarding the response to the requesting entity. The node includes a first interface for receiving requests to check an identity of a user equipment in a first protocol and a second interface for receiving requests to check an identity of a user equipment in a second protocol, such that a user equipment that is blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol.

The subject matter described herein can be implemented in software in combination with hardware and/or firmware. For example, the subject matter described herein can be implemented in software executed by a processor. In one exemplary implementation, the subject matter described herein can be implemented using a non-transitory computer readable medium having stored thereon computer executable instructions that when executed by the processor of a computer control the computer to perform steps. Exemplary computer readable media suitable for implementing the subject matter described herein include non-transitory computer-readable media, such as disk memory devices, chip memory devices, programmable logic devices, and application specific integrated circuits. In addition, a computer readable medium that implements the subject matter described herein may be located on a single device or computing platform or may be distributed across multiple devices or computing platforms.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the subject matter described herein will now be explained with reference to the accompanying drawings, wherein like reference numerals represent like parts, of which:

FIG. 1 is a block diagram illustrating an exemplary system for providing a multi-network EIR service according to an embodiment of the subject matter described herein;

FIG. 2 is a block diagram illustrating an exemplary system for providing a multi-network EIR service in response to receiving Diameter based signaling messages according to an embodiment of the subject matter described herein;

FIG. 3 is a block diagram illustrating an exemplary system for providing a multi-network EIR service via utilization of a local EIR database provisioned on a network node according to an embodiment of the subject matter described herein;

FIG. 4 is a block diagram illustrating an exemplary system for providing a multi-network EIR service in response to receiving Diameter based signaling messages via utilization of a local EIR database provisioned on a network node according to an embodiment of the subject matter described herein;

FIG. 5 is a block diagram illustrating an exemplary internal architecture of a network node configured to provide a multi-network EIR service according to an embodiment of the subject matter described herein; and

FIG. 6 is a flow chart illustrating an exemplary process for providing a multi-network EIR service according to another embodiment of the subject matter described herein; and

FIG. 7 is a high level block diagram of a general purpose computer system suitable for use in providing multi-network EIR service according to an embodiment of the subject matter described herein.

DETAILED DESCRIPTION

In accordance with the subject matter disclosed herein, systems, methods, and computer readable media are provided for providing a multi-network equipment identity register. Reference will now be made in detail to exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

FIG. 1 is a block diagram illustrating an exemplary system for providing a multi-network EIR according to an embodiment of the subject matter described herein. In the embodiment illustrated in FIG. 1, system 100 includes a network node 102 (e.g., a signaling transfer point (STP)) that is located in a telecommunications network and is communicatively connected to an equipment identity register (EIR) 108, e.g., an EIR database and/or a server hosting an EIR database. In one embodiment, EIR 108 may comprise and/or serve as a national EIR registry database.

In some embodiments, network node 102 may include a first interface 104 for receiving requests to check an identity of a user equipment (UE) in a first protocol and a second interface 106 for receiving requests to check an identity of a UE in a second protocol, wherein the first protocol and second protocol are distinct and different from each other. Although FIG. 1 depicts network node 102 as supporting two protocols via two interfaces, additional protocols and/or interfaces may be utilized without departing from the scope of the disclosed subject matter.

In some embodiments, network node 102 may include an EIR service module 114 that is configured to manage interfaces 104-106, to process received signaling messages (e.g., identity check request messages and EIR response messages), to query EIR 108, and the like. In the embodiment illustrated in FIG. 1, first interface 104 may be configured to support the SS7 protocol and second interface 106 may be configured to support the Diameter protocol. In some

embodiments, first interface 104 supports the GSM/F protocol for communications between an MSC 110 and EIR 108 (e.g., a server or network node hosting an EIR database). In some embodiments, second interface 106 supports the Diameter S13 protocol to facilitate communication between a mobility management entity (MME) 112 and EIR 108 and/or the Diameter S13' protocol for facilitating the communication between a serving general packet radio services support node (SGSN) that supports the S4 interface (e.g., referred to as an S4-SGSN) and EIR 108.

In some embodiments, network node 102 may receive, from a message originator, a request (e.g., a signaling message request) to check the identity and/or identification number of UE 101 (e.g., any mobile phone, mobile tablet, or other like mobile device capable of wireless communications) at either of its two interfaces 104 or 106. As illustrated in FIG. 1, UE 101 may attempt to establish a communications connection (e.g., to register, attach, initiate a call/text, etc.) with MSC 110 via a base station (not shown). Accordingly, MSC 110 may be configured to send a request message 120 (e.g., a GSM MAP Check_IMEI message) to network node 102 via an SS7 link communicatively connecting (either directly or indirectly) MSC 110 to first interface 104 (e.g., an SS7 interface). In some embodiments, request message 120 may contain an identity of UE 101 (e.g., the IMEI value). In some embodiments, request message 120 may also include a subscriber identifier. In the embodiment illustrated in FIG. 1, for example, request message 120 includes an international mobile subscriber identity (IMSI) of the user associated with UE 101. For GSM phones, the IMEI is stored in integrated hardware components (e.g., on a logic board chip) of UE 101 while the IMSI is stored in a subscriber identity module, or SIM card, utilized by UE 101. In some embodiments, MSC 110 may send request message 120 in response to an initial attachment or registration of UE 101 to the network, or in response to other trigger conditions, such as a receiving a location update, receiving other MAP requests, and the like. The sending of request message 120 may also be triggered if the movement of UE 101 requires an inter-MSC handover, if UE 101 receives or originates a call, and/or if the UE receives or originates an SMS message (e.g., a text message) or MMS message).

Supporting EIR requests of different protocols allows network node 102 to provide the capability that a UE device that is blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol. For example, if a dual mode mobile phone that can operate in both 3G and 4G networks is stolen, and the 3G network operator adds that UE device to a blacklist maintained in EIR 108, then not only will the stolen device be barred from operation in the 3G network, the stolen device will also be barred from operating in a 4G network as well. Returning to FIG. 1, network node 102 receives request message 120 from MSC 110 and, in response, EIR service module 114 may be configured to send an associated query message 122 to EIR 108. For example, SS7-based message 120 may be a "route on SSN" message, in which case network node 102 can determine if the destination SSN included in message 120 is the same as the SSN assigned to a server hosting an EIR database (e.g., EIR 108). If so, EIR service module 114 may enable network node 102 to conduct the EIR query itself by generating and sending message 122 to EIR 108. If received message 120 is a "route on global title translation" message, EIR service module 114 on network node 102 may first check the service field of message 120 to determine if the service indicator="EIR". If such a determination is made, network node 102 may perform the EIR query by sending message 122 to EIR 108 as shown in FIG. 1.

Upon receiving query message **122**, EIR **108** (e.g., the server hosting EIR **108**) may determine if UE **101** is included as an entry in the EIR **108**. Specifically, EIR **108** may utilize the IMEI provided in received message **122** to cross-reference entries listed in the blacklists, whitelists, and/or greylists included in EIR **108**.

In some embodiments, EIR **108** receives a query message **122**, such as a Check_IMEI query containing the IMEI (and optionally the IMSI also) and responds with restriction data that provides an indication as to whether to allow the associated UE to attach to the network or not. For example, the restriction data may include information that indicates whether UE **101** is "blacklisted", "whitelisted", and/or "greylisted". As used herein, a "blacklisted" device can include a UE device which EIR **108** reports as being prohibited from attaching to or using the network. UE devices can be blacklisted for a variety of reasons, the most common being that the UE was stolen from its rightful owner, who reported the theft to the networks. Blacklisting is intended to discourage theft of cell phones, since the stolen phone will, in theory, be quickly barred from use on the network. Likewise, as used herein, a "whitelisted" device includes a UE device which EIR **108** reports as being allowed to attach to and use the network. Similarly, a "greylisted" device is a UE device which FIR **108** reports as being allowed to attach to and use the network, but which EIR **108** flags as being suspicious and/or worthy of further observation. For example, if result message **126** in FIG. **1** includes restriction data indicating that UE **101** is greylisted, MSC **110** may subsequently notify the network operator of the presence of the greylisted device on the network, or initiate actions to monitor or track UE **101**.

Returning to the embodiment of FIG. **1**, upon locating restriction data that indicates whether UE **101** is blacklisted, whitelisted, and/or greylisted, EIR **108** can send a response message **124**, which contains the result/response to query **122**, to network node **102**. EIR service module **114** in network node **102** subsequently sends the received restriction data result (illustrated as response message **126**) back to the original requesting node, i.e., MSC **110**.

Notably, this situation is complicated by the fact that a single UE may be a multi-mode device that includes multiple different SIM cards, such that a UE's single IMEI may be associated with multiple IMSIs (corresponding to the different SIM cards). For this reason, EIR **108** may be configured such that, if an IMEI query results in finding restriction data that indicates UE **101** as being blacklisted, EIR **108** may additionally check the IMSI value provided by network node **102** as well. If EIR **108** determines that the IMSI value is valid, EIR **108** may report UE **101** as being whitelisted (e.g., the restriction data may include a null value or other similar indication). Thus, in such an embodiment, a blacklisted IMEI may be overridden by a finding that an IMSI associated with UE **101** is whitelisted.

FIG. **2** is a block diagram illustrating an exemplary system for providing a multi-network EIR service in response to receiving a Diameter based message according to an embodiment of the subject matter described herein. For example, FIG. **2** depicts the same system **100** shown in FIG. **1** but instead illustrates the communication between MME **112** and network node **102**. Notably, network node **102**'s second interface **106** allows network node **102** to provide EIR services to other networks that utilize other types of protocols as well. In the embodiment illustrated in FIG. **2**, network node **102** may comprise an STP within an SS7 network that includes a second interface **106** compatible with the Diameter protocol, thereby allowing non-GSM network elements (e.g., network elements that use Diameter protocol rather than SS7) to

access EIR **108**. In the embodiment illustrated in FIG. **2**, for example, MME **112** may be triggered to send a Diameter protocol message **220** (e.g., a Check_IMEI" message) to check an identity of UE **101**, wherein message **220** is received by network node **102**'s Diameter interface (i.e., interface **106**). In response, EIR service module **114** in network node **102** generates and sends a query message **222** to EIR **108**. Upon receiving query message **222**, EIR **108** may determine if UE **101** is included as an entry in its databases. Specifically, EIR **108** may utilize the IMEI provided in received message **222** to cross-reference entries listed in the blacklists, whitelists, and/or greylists included in EIR **108**. After determining if the IMEI is blacklisted, whitelisted, and/or greylisted, EIR **108** may send the determined restriction data result via response message **224** back to network node **102**. Network node **102**, in turn, sends the restriction data result via message **226** to the original querying node, MME **112**. In one embodiment, MME **112** or other Diameter nodes may establish a session with network node **102** for the purpose of performing Check_IMEI queries.

In the embodiments illustrated in FIGS. **1** and **2**, network node **102** receives a query result from EIR **108** and forwards that result to the node which sent the original query (i.e., MSC **110** in FIG. **1** and MME **112** in FIG. **2**), but in alternative embodiments, node **102** may modify the result from EIR **108** before sending the message on or generate a new message and send that modified message instead. Likewise, although FIGS. **1** and **2** perform queries using an IMEI and optionally an IMSI, other types of identifiers could be used, such as a Mobile Subscriber Integrated Services Digital Network-Number (MSISDN), and the like.

While FIGS. **1** and **2** depict EIR **108** as being a network element that is separate from network node **102**, some embodiments of the disclosed subject matter may include the EIR being co-located with, or a component of, network node **102**. For example, FIG. **3** depicts a system **300** that includes a network node **302** in a telecommunications network that includes a first interface **304** for receiving requests to check an identity of a UE in a first protocol and a second interface **306** for receiving requests to check an identity of a UE in a second protocol, wherein the first protocol and second protocol are distinct and different from each other. Although FIG. **3** depicts network node **302** as supporting two protocols via two network interfaces, additional protocols and/or interfaces may be utilized without departing from the scope of the disclosed subject matter. Notably, system **300** of FIG. **3** is similar to system **100** illustrated in FIG. **1** with the exception that the EIR database is maintained and hosted by network node **302** (i.e., the EIR is not externally located from network node **302**).

For example, network node **302** may receive, from a message originator, a request (e.g., a signaling message request) to check the identity of UE device **301** (e.g., any mobile phone, mobile tablet, or other like mobile device capable of wireless communications) at interface **104**. As illustrated in FIG. **3**, MSC **310** may be configured to send a request message **320** (e.g., a GSM MAP Check_IMEI message) to network node **302** via an SS7 link communicatively connecting (either directly or indirectly) MSC **310** to first interface **304** (e.g., an SS7 interface). In some embodiments, request message **320** may contain an identity of the user equipment (e.g., the UE's IMEI value). In some embodiments, request message **320** may also include a subscriber identifier (e.g., IMSI) of the user associated with UE **301**.

Upon network node **302** receiving request message **320** from MSC **310**, EIR service module **314** may be configured to decode message **320** and access local EIR **308** in order to

obtain the desired EIR information (i.e., without utilizing any external signaling messages). For example, EIR **308** may utilize the IMEI provided in received message **320** to cross-reference entries listed in the blacklists, whitelists, and/or greylists included in EIR **308**. After obtaining the desired EIR information (e.g., blacklist, whitelist, and/or greylist restriction data) associated with the IMEI, EIR service module **314** in network node **302** may be configured to generate and send a result message **322** containing the determined restriction data to the original querying node, MSC **310**.

FIG. **4** is a block diagram illustrating an exemplary system for providing a multi-network EIR service in response to receiving Diameter based signaling messages via utilization of a local EIR database provisioned on a network node according to an embodiment of the subject matter described herein. Notably, system **400** of FIG. **4** is similar to system **200** illustrated in FIG. **2** with the exception that the EIR database is maintained and hosted by network node **302** (i.e., the EIR is not externally located from network node **302**). For example, network node **302** may receive, from a message originator, a request (e.g., a signaling message request) to check the identity of UE **101** at interface **104**. As illustrated in FIG. **4**, MME **312** may be configured to send a request message **420** (e.g., a GSM MAP Check_IMEI message) to network node **302** via an SS7 link communicatively connecting (either directly or indirectly) MME **312** to first interface **404** (e.g., a Diameter interface). In some embodiments, request message **420** may contain an identity of the user equipment (e.g., the UE's IMEI value). In some embodiments, request message **320** may also include a subscriber identifier (e.g., IMSI) of the user associated with UE **301**.

Upon network node **302** receiving request message **320** from MME **312**, EIR service module **314** may be configured to decode message **320** and access local EIR **308** in order to obtain the desired EIR information (i.e., without utilizing any external signaling messages). For example, EIR service module **314** may utilize the IMEI provided in received message **420** to cross-reference entries listed in the blacklists, whitelists, and/or greylists included in EIR **308**. After obtaining the desired EIR information (e.g., blacklist, whitelist, and/or greylist restriction data) associated with the IMEI, EIR service module **314** in network node **302** may be configured to generate and send a result message **422** containing the determined restriction data to the original querying node, MME **312**.

FIG. **5** is a block diagram of an exemplary internal architecture of a network node **500** according to an embodiment of the subject matter described herein. In some embodiments, network node **500** may include a signaling transfer point (STP) or any other signaling message routing node. Referring to FIG. **5**, network node **500** may include an interprocessor message transport (IMT) bus **508** that includes two counter-rotating serial rings. A number of processing modules or cards may be coupled to IMT bus **508**. For example, IMT bus **508** may be coupled to a number of communications modules, such as a link interface module (LIM) **510**, an asynchronous transfer mode LIM (ATM-LIM) **520**, and an Internet protocol LIM (IP-LIM) **530**. These modules are physically connected to bus **508** such that signaling and other types of messages may be routed internally between active cards or modules. For simplicity of illustration, only a single LIM card, a single ATM-LIM card, and a single IP-LIM card are included in FIG. **5**. However, network node **500** may include multiple LIMs, data communication modules, and other card types, all of which may be simultaneously connected to and communicating via IMT bus **508**.

In some embodiments, network node **500** may also include a pair of a pair of MASP processor modules **504-506** communicatively connected to IMT bus **508**. Notably, MASP processor modules **504-506** may be configured implement maintenance and administration subsystem functions, such as maintenance communications, initial program loading, peripheral services, alarm processing, and system disk functionality, for network node **500**.

In some embodiments, network node **500** may include a plurality of service modules (xSMs) **540-550** that are communicatively connected via IMT bus **508**. Service module **540**, for example, may comprise a database services module (DSM) that is configured to host one or more signaling message processing applications, such as a multi-network EIR service, global title translation (GTT), flexible routing, number portability translation, ENUM, call screening, pre-paid calling service, mobile services, 800 number service, caller identification service, and other applications that involve routing or application layer signaling message processing. In some embodiments, LIMs **510-530**, xSMs **540-550**, and other processor modules may be provisioned and operated simultaneously within network node **500**, so as to form a highly scalable, reliable message processing system. Notably, each of modules **510-550** may execute applications or functions that reside on each module and control communication with other modules via bus **508**. For example, xSM **540** may execute software (e.g., via a processor or the like) that applies the aforementioned EIR service to communications sessions involving a mobile originating or terminating device.

In some embodiments, a multi-network EIR may be stored in a service module (e.g., xSM **540** or **550**) which is provisioned by a customer provisioning system or application, generally designated **580**. For example, customer provisioning system **580** may be configured to communicate with a primary provisioning application processor (PAP) **560** included in network node **500**. Notably, customer provisioning system **580** may communicate write and read instructions with a provisioning database application (PDBA) **562** included in PAP **560** via a provisioning database interface (PDBI). In some embodiments, the PDBI may comprise a transaction based interface over a Simple TCP/IP socket connection.

PAP **560** may further include a provisioning database (PDB) **564** and a real time database (RTDB) **566**. In some embodiments, PDB **564** may be executed on a blade based PAP server and includes a readable and secure master copy of an EIR database. Similarly, RTDB **566** comprises a database that may include a reorganization of the data contained in PDB **564**. For example, the data in RTDB **566** may be organized in a manner that improves and/or optimizes data look-ups for the benefit of network node **500**. In some embodiments, PAP **560** may be duplicated for redundancy and replicated on a mated node (not shown). For example, a backup PAP **570** may contain a RTDB **576** that stores a binary copy of RTDB **566**.

In some embodiments, customer provisioning system **580** may be configured by a network operator to provision network node **502**. For example, system **580** may initiate a write transaction to communicate write operation commands to PDBA **562** via the PDBI. Upon receiving and processing the commands, PDBA **562** closes the write transaction. In some embodiments, PDBA **562** accepts/commits any commands determined to be valid while rejecting any commands identified as being invalid. PDBA **562** may subsequently communicate a response message to customer provisioning system **580** to indicate which commands were accepted and/or rejected. In some embodiments, PDBA **562** utilizes data from

the write transaction to securely update PDBA **562** and RTDBs **566** and **576**. Similarly, PDBA **562** may also be configured to utilize data from the write transaction to securely update a PDB and/or a RTDB in a mated node. After these databases are updated, PDBA **562** (using RTDB **566**) may be configured to broadcast the updated information to RTDB **546-556** stored in SM **540-550** in a parallel manner.

FIG. **6** is a flow chart illustrating an exemplary method **600** for providing a multi-network EIR service according to another embodiment of the subject matter described herein. In the embodiment illustrated in FIG. **6**, method **600** includes, at step **602**, receiving, at a node in a telecommunications network having a first interface for receiving requests to check an identity of a user equipment in a first protocol and a second interface for receiving requests to check an identity of a user equipment in a second protocol, a request from a requesting entity to check an identity of a user equipment, the request containing an identity of a user equipment. At step **604**, the identity of the user equipment is used to query an EIR. At step **606**, a response to the query is received from the EIR. At step **608**, the response is forwarded to the requesting party.

The methods and systems described herein include several advantages over conventional systems. For example, for GSM network operators that have an existing EIR database, the systems and methods described herein allow them to make the EIR database available to 4G networks, either their own 4G network or a 4G network owned by another operator. By doing this, the 4G vendor does not need to create its own EIR database, but can instead reuse or take advantage of a legacy EIR database.

By making a single EIR database available to multiple networks, when a device having multiple radio interfaces (GSM, LTE, etc.) is stolen and reported to the network operator, an entry for that device is placed in EIR **108**—which means that, regardless of the network that thief attempts to use, the device will be properly flagged as being blacklisted. In contrast, conventional systems maintained EIR databases for each type of network, which meant that it was possible that a device might be blacklisted in a GSM network but not blacklisted in an LTE network, for example.

FIG. **7** depicts a high level block diagram of a general purpose computer system suitable for use in performing the functions described herein. As depicted in FIG. **7**, system **700** comprises a processor **702**, a memory **704**, a storage device **706**, and communicatively connected via a system bus **708**. In some embodiments, processor **702** can comprise can comprise a microprocessor, central processing unit (CPU), or any other like hardware based processing unit. In some embodiments, an EIR service module **710** can be stored in memory **704**, which can comprise random access memory (RAM), read only memory (ROM), optical read/write memory, cache memory, magnetic read/write memory, flash memory, or any other non-transitory computer readable medium. In some embodiments, processor **702** and memory **704** can be used to execute and manage the operation of EIR service module **710**. In some embodiments, storage device **706** can comprise any storage medium or storage unit that is configured to store data accessible by processor **702** via system bus **708**. Exemplary storage devices can comprise one or more local databases hosted by system **700**.

In some embodiments, the disclosed subject matter includes a system for providing a multi-network equipment identity register (EIR) that comprises a network node in a telecommunications network that is configured to:
receive, from a requesting entity, an identity check request message containing an identity of a user equipment;

query an FIR using the identity of the user equipment to determine if any restriction data corresponding to the user equipment exists in the EIR; and
forward the existing restriction data to the requesting entity,
wherein the network node includes a first interface for receiving identity check request messages to check the identity of the user equipment in a first protocol and a second interface for receiving identity check request messages to check the identity of the user equipment in a second protocol, wherein if the existing restriction data indicates that the use of the user equipment is restricted in a network that uses the first protocol, the user equipment is similarly restricted in a network that uses the second protocol.

In some embodiments of the aforementioned system, the EIR comprises an EIR database located within the network node.

In some embodiments of the aforementioned system, the EIR database is provisioned with restriction data by a customer network provisioning system.

In some embodiments of the aforementioned system, the EIR comprises an EIR database that is hosted by a network element that is distinct and separate from the network node.

In some embodiments of the aforementioned system, the restriction data includes blacklist data, greylist data, and/or whitelist data.

In some embodiments of the aforementioned system, the requesting entity sends the identity check request message in response to at least one of: receiving a registration request from the user equipment, receiving a network attachment request from the user equipment, receiving a location update message from the user equipment, receiving a message attempting to initiate a call from the user equipment, receiving a message attempting to send a short message service (SMS) message from the user equipment, or receiving a mobile terminated message directed to the user equipment.

It will be understood that various details of the subject matter described herein may be changed without departing from the scope of the subject matter described herein. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation.

What is claimed is:
1. A system for providing a multi-network equipment identity register (EIR), the system comprising:
a node in a telecommunications network configured to:
receive from a requesting entity a request to check an identity of a user equipment, the request containing the identity of the user equipment;
query an EIR using the identity of the user equipment;
receive a response from the EIR; and
forward the response to the requesting entity,
wherein the node includes a first interface for receiving an identity check request to check an identity of user equipment in a first protocol and a second interface for receiving an identity check request to check an identity of user equipment in a second protocol, the second protocol being different from the first protocol and the identity of the user equipment in the second protocol being different from the identity of the user equipment in the first protocol, such that user equipment blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol.
2. The system of claim **1** wherein the node comprises a signaling transfer point (STP).

3. The system of claim **1** wherein the identity of the user equipment comprises an international mobile station equipment identity (IMEI).

4. The system of claim **3** wherein the request to check the identity of the user equipment comprises a Check IMEI message.

5. The system of claim **1** wherein the request to check the identity of the user equipment also contains an international mobile subscriber identity (IMSI).

6. The system of claim **1** wherein the first interface is an SS7 interface for sending and receiving SS7 protocol messages.

7. The system of claim **6** wherein the request to check the identity of the user equipment comprises a global system for mobile communications (GSM) mobile application part (MAP) protocol message or an IS-41 MAP protocol message.

8. The system of claim **1** wherein the second interface is a Diameter interface for sending and receiving Diameter protocol messages.

9. The system of claim **8** wherein the second interface is a Diameter S13 interface or a Diameter S13' interface.

10. The system of claim **8** wherein the request to check the identity of the user equipment comprises a Diameter protocol message.

11. A method for providing a multi-network equipment identity register (EIR), the method comprising:

at a node in a telecommunications network:

   receiving from a requesting entity a request to check an identity of a user equipment, the request containing the identity of the user equipment;

   querying an EIR using the identity of the user equipment;

   receiving a response from the EIR; and

   forwarding the response to the requesting entity,

   wherein the node includes a first interface for receiving an identity check request to check an identity of user equipment in a first protocol and a second interface for receiving an identity check request to check an identity of user equipment in a second protocol, the second protocol being different from the first protocol and the identity of the user equipment in the second protocol being different from the identity of the user equipment in the first protocol, such that user equipment blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol.

12. The method of claim **11** wherein the node comprises a signaling transfer point (STP).

13. The method of claim **11** wherein the identity of the user equipment comprises an international mobile station equipment identity (IMEI).

14. The method of claim **11** wherein the request to check the identity of the user equipment comprises a Check IMEI message.

15. The method of claim **11** wherein the request to check the identity of the user equipment contains an international mobile subscriber identity (IMSI).

16. The method of claim **11** wherein the first interface is an SS7 interface for sending and receiving SS7 protocol messages.

17. The method of claim **16** wherein the request to check the identity of the user equipment comprises a global system for mobile communications (GSM) mobile application part (MAP) protocol message or an IS-41 MAP protocol message.

18. The method of claim **11** wherein the second interface is a Diameter interface for sending and receiving Diameter protocol messages.

19. The method of claim **18** wherein the request to check the identity of the user equipment comprises a Diameter protocol message.

20. A non-transitory computer readable medium having stored thereon executable instructions that when executed by the processor of a computer control the computer to perform steps comprising:

at a node in a telecommunications network:

   receiving from a requesting entity a request to check an identity of a user equipment, the request containing the identity of the user equipment;

   querying an equipment identity register (EIR) using the identity of the user equipment;

   receiving a response from the EIR; and

   forwarding the response to the requesting entity,

   wherein the node includes a first interface for receiving an identity check request to check an identity of user equipment in a first protocol and a second interface for receiving an identity check request to check an identity of user equipment in a second protocol, the second protocol being different from the first protocol and the identity of the user equipment in the second protocol being different from the identity of the user equipment in the first protocol, such that user equipment blacklisted in a network that uses the first protocol is also blacklisted in a network that uses the second protocol.

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